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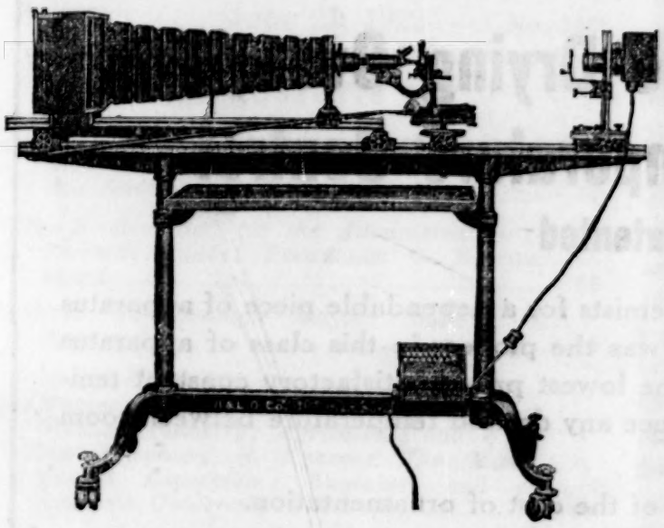

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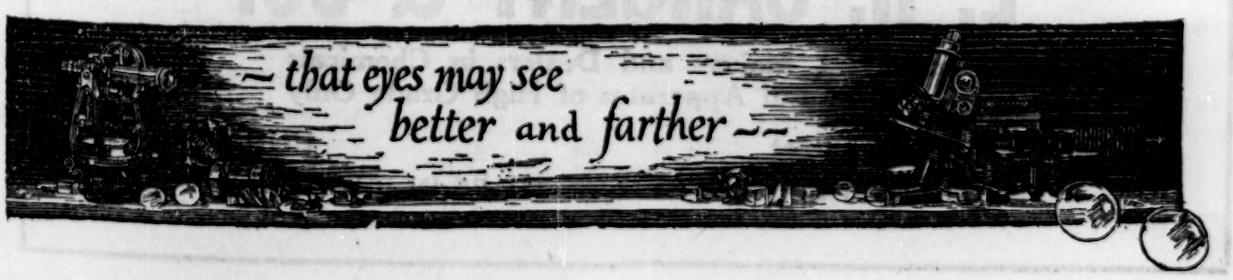

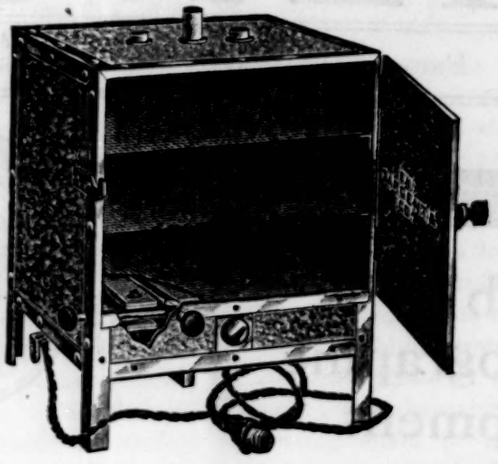

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CONSERVATION OF THE WATERS OF THE COLORADO RIVER FROM THE STANDPOINT OF THE RECLAMATION SERVICE[1]

THE Colorado River Basin includes the largest river system lying entirely within the arid region. Its average annual discharge is nearly 18,000,000 acre-feet and it drains 244,000 square miles of territory, nearly all in the United States, less than one per cent. of the area and an insignificant part of the water coming from Mexico. The basin lies in seven different states of the Union and all of them can and should receive benefit from the use of its waters. The trunk stream was navigated for many years from the gulf northward a distance of over 400 miles and before the advent of railroads this navigation was important. It has recently been largely abandoned but the stream is technically and actually navigable. Most of the course of the main stream is in the United States, but for a distance of about 20 miles it forms the boundary between Mexico and Arizona and for about 80 miles flows through Mexican territory. It is therefor an international stream, an interstate stream, and a navigable stream. The waters of the stream not heretofore appropriated to private use are the property of the United States government and the lands necessary for its proper development and use are mainly public lands. Its problems and their administration are therefore distinctly national.

Like most of the streams of the world the discharge of the Colorado River varies greatly in volume. Its low water discharge frequently falls below 5,000 cubic feet per second, and its flood sometimes peaks above 200,000 cubic feet per second. Numerous small valleys are

[1] Presented at the joint meeting of the American Association for the Advancement of Science and the Pacific Division, Salt Lake City, June 23, 1922.

irrigated from the tributaries of the Colorado River and their aggregate use of its waters is very important. The largest valley which the Colorado irrigates is the Imperial Valley in southern California. Smaller diversions from the river are in the Palo Verde Valley of California and the Yuma Valley of Arizona. These valleys can of course receive only the waters left after the diversion in the basin above and in years of low water the entire available flow of the river is utilized in the lower valleys. A much larger quantity is needed to fully develop these valleys and this can not be secured without the storage of the flood flow at some point above. Hence arises the problem of the conservation of the waters of the Colorado River.

This problem has been under investigation by the Reclamation Service ever since the year of its organization, 1902. In this it has had the cooperation of the Geological Survey in the measurement of streams and of the Agricultural Department in the examination of soils. The investigation has been carried on in all parts of its vast basin, many dam sites have been explored with diamond drill, and the results have been condensed in various reports, the latest and most comprehensive of which has been recently published as Senate Document No. 142 entitled "Problems of Imperial Valley and vicinity."

The topography of the Colorado River Basin is admirably adapted to the conservation of its waters and their use for power. Several good reservoir sites have been found at advantageous locations. The main stream below its junction with Green River has a total fall of nearly 4,000 feet to sea level, fully three fourths of which are physically capable of being developed for power, and the greater portion of the waters of the basin can be made available for use in this stretch. The main trunk of Green River above the junction falls over 2,000 feet and the upper fork or Grand River has a fall of nearly 4,000 feet. The average potential power in the basin at present is over 8,000,000 horse power. Some of this is unavailable for development for various reasons and some of the water will ultimately be consumed in irrigation, so that the ultimate available is about 6,000,000 horse power, of which more than two thirds is on the main stream, mostly within the state of Arizona or on its boundaries.

During the past twenty years many engineering examinations of the main stream of the Colorado River have been made by power interests, with a view to the estimation of its power possibilities, and though these were uniformly reported as great, the engineers have until recently agreed in the conclusion that there was no available market; but the markets have been growing and the feasibility of transmitting large blocks of power has also been improving. It is believed that the time has at last arrived when the development of power on the lower Colorado River has become feasible at such points as are most accessible and nearest to adequate markets.

The use of the waters of the Colorado for irrigation presents problems of considerable difficulty. Most of the river is in canyons where no valleys are adjacent and its use in irrigation is impossible. In the lower reaches the river has formed some alluvial valleys which are in part being irrigated by the natural flow of the stream, but which for full development require a much larger flow of water than is available in the late summer and fall. The present irrigated area can be more than trebled if the water supply is conserved and the complete regulation of the river will furnish a supply greater than the available valley areas. Their reclamation, however, presents great engineering difficulties and imposes upon those lands heavy charges for construction which would be difficult if not impossible for settlers to pay if the entire burden of the conservation and diversion had to be borne by those settlers. Fortunately, however, the conservation for power purposes will so nearly fit with the requirements for irrigation that the utility of the storage sites for the development of power may be utilized as an asset to defray the expenses of regulating the river and thus through the power asset render feasible irrigation enterprises that would not otherwise be feasible.

One of the greatest, and by far the most pressing problems on the Colorado, is the con-

trol of the mighty floods that are sometimes furnished by its drainage basin and which annually threaten to overwhelm and destroy the valleys in its lower reaches. Problems of this kind are presented on every large river flowing through alluvial valleys, but the case of the Colorado is unique and the flood problem is far more important and imminent than usually is the case. This situation is due to the peculiar topographic conditions of the valleys which the river serves.

The Gulf of California formerly extended northwestward to a point a few miles above the town of Indio, about 144 miles from the present head of the gulf. The Colorado River, emptying into the gulf a short distance south of the present international boundary, carried its heavy load of silt into the gulf for centuries, gradually building up a great delta cone entirely across the gulf and cutting off its northern end, which remains as a great depression from which most of the water has been evaporated, leaving in its bottom the Salton Sea of 300 square miles, with its surface about 250 feet below sea level.

The river flowing over its delta cone steadily deposits silt in its channel and by overflow on its immediate banks, so that it gradually builds up its channel and its banks and forms a ridge growing higher and higher until the stream becomes so unstable that it breaks its banks in the highwater period and follows some other course. In this manner the stream has in past centuries swung back and forth over its delta, until this exists as a broad, flat ridge between the gulf and the Salton Sea, about 30 feet above sea level, and on the summit of this the river flows at present, the water finding its way to the southward into the gulf.

The direct distance from Andrade on the Colorado River, where it reaches Mexico, to the head of the gulf is about 75 miles, and the distance to the margin of Salton Sea is but little more. As that latter is about 250 feet lower than the gulf, the strong tendency to flow in that direction needs no demonstration. This, coupled with the inevitable necessity for such an alluvial stream to leave its channel at intervals, constitutes the menace of the lands lying about Salton Sea, called the Imperial Valley. As there is no escape of water from Salton Sea except by evaporation, the river flowing into this sea would, unless diverted, gradually fill it to sea level or above and submerge the cultivated land and the towns of Imperial Valley, nearly all of which are below sea level. Any flood waters that overflow the bank to the north must therefore without fail be restrained and not allowed to flow northward into Salton Sea. This is now prevented by a large levee, north of Volcano Lake, extending eastward and connecting with high land near Andrade. This levee is in Mexico and its maintenance is complicated thereby.

In 1905 the river scoured out the channel of the Imperial Canal and turned its entire volume into the Salton Basin, eroding a deep gorge and raising the level of Salton Sea. It submerged the salt works and forced the removal of the main line of the Southern Pacific Railroad. At great difficulty and expense, after several unsuccessful attempts, the river was returned to its old channel in February, 1907. The control of the river would be greatly facilitated if the floods were reduced in volume by storage. Investigations have been made concerning the feasibility of storing the floods and reducing their volume to an amount easily controlled.

The regulation of the Colorado River has been examined and discussed a great deal. Some engineers have expressed opinions that the storage of the waters of the Colorado should be accomplished entirely in the upper basin and on the tributaries of the river because in those regions good storage sites can be found which will intercept the major portion of the water supply and will receive those waters very largely free from sediment and nearly clear, whereas the erosion rapidly in progress throughout the canyon region gradually loads the river with sediment so that the water reaching the reservoir sites below the canyon is heavily laden with sediment. Where the river leaves the canyon region it is estimated that it carries on an average about 80,000 acre-feet of sediment annually.

There are, however, many and serious objec-

tions to this plan. Reservoirs above the canyon region, while in the long run intercepting the major portion of the waters, leave unregulated the sudden floods to which the lower and more arid portion is subject. The Gila Basin alone, while comprising less than one fourth of the area of the basin, sometimes furnishes floods which at their maximum may equal or even exceed those of the main stream above its mouth with nearly four times the drainage area and about fifteen times the mean annual discharge. Complete regulation therefore requires the control of the waters of the Gila as well as those of the Colorado, and the same is true of any other large portion of the basin. If we confine storage to the streams above the Arizona line we can intercept over 80 per cent. of the mean annual flow, but we leave unregulated about 150,000 square miles of drainage area or three fifths of the basin. This area while arid and unreliable as to water supply, is, like the Gila Basin, subject to torrential rains and would in the aggregate leave a flood menace that would have to be met in some other way if the lands are to be protected.

It is obvious that the nearer the reservoir can be built to the lands in the lower valley the more complete will be its flood regulation, and it also happens that the lowest reservoir site of adequate capacity, which is at Boulder Canyon, lies at a point within transmission distance of the Pacific Coast and thus renders available for its construction the vast power asset which is not available to any adequate reservoir site existing above this point. Fortunately it is possible here to build a dam as high as may be required and to furnish thereby not only complete regulation of the river flow but a surplus capacity which will store the sediment for centuries to come without impairing the head on the power plants to be served therefrom. In the distant future it will become necessary to furnish additional storage by building reservoirs above, but this requirement will be more than a century away and in that time certain regulation of the river is likely to be accomplished by reservoirs on its tributaries and the problem can be easily and practically met when it arises.

Investigations have demonstrated the feasibility of building a dam of sufficient height to form a reservoir in Boulder Canyon of more than 30,000,000 acre-feet capacity, which is more than actually required to accomplish the proposed solution of the conservation problems that are now imminent. The feasibility and perfection of this accomplishment and the economy with which it will conserve the waters of the Colorado River for their best uses, are in strong contrast to the results that would be obtained by reservoirs in the upper basin. Good sites for storage and the development of power exist on the Green, the Grand and the Yampa, all of which have been carefully surveyed by the Reclamation Service, and their possibility established. These reservoirs could be built one at a time as needed and individually would cost much less than a large reservoir on the lower river, but if their construction were undertaken to meet the present needs of the lower valleys, they would necessarily be operated in accordance with those needs and this would destroy their usefulness for power development and irrigation in the upper basin where they are needed and for which purposes there are no substitutes. To attempt such a solution would therefore interpose obstacles of a legal and financial nature to the proper development of the upper states and virtually destroy a large part of the potential resources of those states because most of the projects would become infeasible if loaded with the additional burdens of the extinguishing rights which such a program would establish. The preservation of the resources of the upper states and the elimination of serious obstacles to their development is the strongest argument in favor of storage on the lower river and the preservation of the reservoir sites in the upper basin for local use. It is thus seen that the conservation and proper use of the waters of the Colorado Basin are in some sense one great problem which must be considered as a whole, otherwise there is danger of virtual destruction of natural resources by throwing obstacles in the way of the development which at best is in many cases difficult and expensive.

The recognition of this relation has led to common action on the part of the seven states

affected and of the Congress of the United States, which has provided for a commission to consider the equitable division of the waters of the Colorado River. On this commission the United States is represented by its chairman, Honorable Herbert Hoover, secretary of commerce, whose ability and fidelity to public duty are recognized in every household of the land. It is hoped that under his leadership an agreement can be reached among the states which can be ratified by the United States and which will provide for the full use of the waters of the Colorado River without imposing unbearable burdens on any part of the basin nor destroy any of its resources.

In order to make a large storage reservoir in the lower basin financially feasible, it will be necessary to charge the major portion of the cost of the storage dam to power. The development of power and irrigation are closely related in that the amount of power which it is practicable to develop depends largely upon the extent of the development of the irrigable lands in the entire drainage basin. The extremely arid and semi-tropic character of the lands in the lower Colorado Basin makes it necessary to irrigate throughout the year and irrigation requirements therefore conform more nearly to the requirements for power than do those in northern latitudes. The capacity of the reservoir provided for power purposes will depend wholly on the relation of its cost to the value of additional power obtainable therewith.

As the point of complete utilization of the streams is approached, the excess water will occur in such widely separated periods as to require a disproportionate amount of storage for its utilization. It has been assumed that all the water must primarily be conserved for irrigation use. By utilizing the minimum head on the turbines as determined by silt storage in the entire Colorado River Basin, 600,000 firm horsepower of electric energy can be developed at Boulder Canyon and 700,000 horsepower is feasible with the same reservoir in connection with the full development of the irrigable lands in the upper basin and about 1,500,000 acres in the lower basin which it is practicable to develop in the near future. In either case there will be a large amount of secondary power which will be of considerable value. Installation of a power plant to develop a large amount of power may be desirable for the reason that although the development of the upper basin will doubtless proceed steadily it will be a long time before the full development is reached. The immense amount of power to be generated and the variable head under which the turbines will be required to work will make the Boulder Canyon plant one of the most remarkable ever built. Under present plans the power house would be located on the downstream toe of the dam in the event a gravity dam is built, or along the canyon wall below the dam if an arch dam is constructed.

Among the more important reservoir sites in the upper basin which have been carefully investigated by the Reclamation Service are the following: the Flaming Gorge on the Green River, where a dam 327 feet high would create a reservoir with storage capacity of 4,000,000 acre feet; the Juniper on the Yampa River, where a dam 268 feet high would create a reservoir of 1,500,000 acre feet capacity; the Dewey located on the Grand River with a dam 275 feet high, which would create a reservoir of 2,270,000 acre feet capacity. The foundations of these sites have been tested with diamond drill and the foundations are known to be satisfactory.

The choice of a reservoir site on the lower Colorado River depends upon numerous factors of which a few may here be enumerated:

First, for flood control the reservoir should be as near the area to be protected as possible.

Second, for irrigation with ultimate supply but little in excess of demands, control must be had as near the ultimate diversion as possible for the prevention of waste due to inability to coordinate demand and supply.

Third, the generation of power, incidental to irrigation operations, should be carried on as near as possible to its market.

Fourth, the site should be as close to established railroads as possible to cut down construction costs.

Fifth, with due allowance for costs the reservoir should be as deep as possible in

order to expose the minimum possible area for evaporation losses and prevent waste of water thereby.

Sixth, lowest possible cost giving due weight to other considerations.

From all data available to date, the Black or Boulder Canyon sites, only 18½ miles apart by river, seem to fill the above requirements more nearly than any other site or sites which have been found.

The proper size of the reservoir is a matter not yet fully determined, the factors entering into this feature being irrigation storage, flood detention storage, silt storage and power development.

The maximum capacity so far considered is 31,400,000 acre feet, including 5,000,000 acre feet of silt storage, 11,400,000 acre feet for irrigation storage, 10,000,000 acre feet for power development and 5,000,000 acre feet for flood control. Other capacities considered have varied from 8,000,000 acre feet up to the maximum. Recent estimates include a reservoir, with dam located in Black Canyon to store 23,500,000 acre feet, which would leave a 200 foot head available for the development of power between this reservoir and the so-called Diamond Springs power project.

If built for flood control purposes alone, a reservoir with capacities of 5,000,000 and 8,000,000 acre feet is estimated to be sufficient to hold discharges at Yuma due to upstream floods down to 75,000 and 50,000 second feet respectively except in rare instances. In connection with a reservoir for irrigation purposes, the addition of 5,000,000 acre feet storage for flood control alone is expected to provide the desired reduction in floods.

In order to visualize the size of the reservoir to be impounded it may be said that in case of the largest reservoir considered, the lake when full will have a surface of 240 square miles and will be about 90 miles long, with a 40 mile arm extending up the Virgin River. If all the water in the reservoir were to be discharged through a conduit 10 feet in diameter at the rate of 10 feet per second it would require six years to empty the reservoir provided no water entered it during that time and neglecting evaporation losses.

A great many preliminary designs and estimates have been prepared of various types of dam for both Boulder and Black Canyons in connection with various plans for the development of power. The conclusion reached is that a dam of the gravity type, built on a curved plan, is the most conservative in design and best suited to a dam of such unprecedented height.

The dam in Boulder Canyon proposed for the largest reservoir considered would be 600 feet high above the present low water surface in the river and 750 feet from the lowest point in the foundation to the highest point on the dam. This would be more than twice the height of Arrowrock Dam, which is 348½ feet high and which, at present, is the highest dam in the world. The length on top would be approximately 1,250 feet and at the bottom the dam would be nearly as long up and down stream as it is high. The amount of concrete required to build the dam and appurtenant structures with a reasonable allowance for contingencies is roughly estimated at 4,700,000 cubic yards. This would be four times the concrete contained in Arrowrock and Elephant Butte dams combined, and if used to build a column 100 feet in diameter, the height of the column would be three miles and would weigh 9½ million tons.

The preliminary estimate of the cost of this dam is about $58,500,000. About 700,000 firm horsepower could be generated with a power plant costing $28,000,000 and the transmission line will cost about $20,500,000 more, or a total of about $107,000,000.

In connection with the dam, it is proposed to provide outlet capacity for the discharge of 25,000 second feet of water for irrigation use and a spillway capacity of 200,000 second feet with water surface in the reservoir 10 feet below the top of the dam. Under conditions of extreme floods the latter will be increased to 300,000 second feet at the time the water surface in the reservoir reaches the top of the dam. As a part of the spillway it is proposed to provide an opening at the bottom of the flood storage with no provision for closure. By this means water would start discharging as soon as the reservoir is full to

the top of the irrigation storage and would continue to discharge as long as there is any water in the space provided for flood detention. This permanent opening would prevent encroachment upon that portion of the reservoir provided for flood detention and will be so designed as not to allow water to pass in excess of the capacity of the levee system in the lower basin.

Excellent dam sites exist in both canyons and after examining them in February, 1921, Dr. F. L. Ransome of the United States Geological Survey pronounced them as geologically feasible for the construction of a high dam.

Probably the most difficult task to be encountered in the construction of a dam on the Colorado River is the turning of the river during construction of the foundation and considerable thought has been given to this feature. A study of the hydrograph of the Colorado at Yuma over the period 1902 to 1921 shows that, if the discharge at Boulder Canyon is assumed to approximate that at Yuma with the exception of the flash peaks thrown into the river from the Gila, a diversion works of 50,000 second feet capacity would have been overtopped every year of the twenty and that the average time of submergence would have been about 11 per cent. of the total, the maximum being about 84 days in 1920 and the minimum 2 days in 1904.

Diversion works of 75,000 second feet capacity would not have been overtopped during nine of the twenty years. The average time of submergence would have been 5 per cent. of the total, the maximum being about 50 days in 1907 and 1909.

Seven of the twenty years of record show peaks of from 115,000 to 190,000 second feet at times occurring in two successive years. In 1920 the peak was 190,000 second feet, while in 1921 it reached 185,700 feet, and the present year promises to be one of high discharge.

With so great an amount of work to be done in excavating and laying concrete below water surface in so short a season it is essential that diversion works of ample capacity be provided to avoid being flooded out, thus losing much valuable time. It is therefore considered necessary to provide for diverting the river during years of ordinary high water and it is proposed to design the works with a capacity of 150,000 second feet. The years 1920 and 1921 are the only ones of record when the discharge exceeded 150,000 second feet at Yuma and it is thought that the expenditure necessary to increase the capacity of the diversion works above 150,000 second feet is unwarranted. Diversion would be by means of cofferdams and tunnels through the rock abutments of the main dam.

In order that the diversion problem may be properly attacked and in order that methods to be used in construction of the dam may be properly worked out, diamond drilling operations to ascertain foundation conditions at the possible dam sites were commenced in September, 1920, and are still under way. To date three sites have been investigated in a preliminary way and considerable detail information has been obtained at one of them. A total of 88 holes have been put down including approximately 3,500 feet of wash borings and 2,100 feet of diamond drilling. The results of the investigations at Boulder Canyon indicate that bed rock will be found at depths not to exceed 140 feet below low water surface. At Black Canyon, bed rock in the deepest hole drilled to date was found at a depth of 62 feet below low water surface. However, the investigations have not been carried far enough for it to be said that this is the maximum depth to bed rock at the Black Canyon site.

The following recommendations by Director Davis conclude his report as provided for in the Kincaid Act:

1. It is recommended that through suitable legislation the United States undertake the construction with government funds of a highline canal from Laguna dam to the Imperial Valley, to be reimbursed by the lands benefited.

2. It is recommended that the public lands that can be reclaimed by such works be reserved for settlement by ex-service men under conditions securing actual settlement and cultivation.

3. It is recommended that through suitable legislation the United States undertake the construction with government funds of a reservoir at or near Boulder Canyon on the lower Colorado

River, to be reimbursed by the revenues from leasing the power privileges incident thereto.

4. It is recommended that any state interested in this development shall have the right at its election to contribute an equitable part of the cost of the construction of the reservoir and receive for its contribution a proportionate share of power at cost to be determined by the secretary of the interior.

5. It is recommended that the secretary of the interior be empowered after full hearing of all concerned to allot the various applicants their due proportion of the power privileges and to allocate the cost and benefits of a highline canal.

6. It is recommended that every development hereafter authorized be required in both construction and operation to give priority of right and use:

First, to river regulation and flood control.

Second, to use of storage water for irrigation.

Third, to development of power.

These recommendations have been embodied in a House bill by Representative Swing of California, introduced April 25, 1922. This bill provides for an advance of $70,000,000 to the reclamation fund to be used for the construction of the Boulder Canyon dam and the Imperial Valley system to be repaid to the general treasury in accordance with the Reclamation Act of 1902.

F. E. WEYMOUTH
U. S. RECLAMATION SERVICE

THE ELECTOR PLAN FOR THE ADMINISTRATION OF RESEARCH FUNDS[1]

ONE of the most effective uses of wealth for the good of mankind lies in the wise encouragement of the search for truth through sustained scientific investigation.

A history of the methods followed through the last two hundred years reveals an astonishing record of unwise provisions in wills and bequests and shows that only in the last few years have economic and legal authorities devoted systematic efforts to the organization of permanent trust funds given for benevolent purposes.

During the last few years, the Community Trust movement has developed a valuable type of organization. The result of this plan has been most gratifying. To cite a single example, in the first six years of its existence, the Cleveland Foundation accumulated a fund of more than one hundred million dollars.

The specific interests of research in science have not yet enjoyed any such encouragement or facilitation through the organization of general public interest. With but slight exceptions, donors are left to hit or miss methods of organization and without appropriate encouragement or aid.

It would therefore seem timely to present an outline of a method of organization which shall be safe and permanent, flexible and adjustable to changing conditions, simple and economic of operation, and inviting as a means of disposing of wealth in the service of science and the establishment of a monument to commemorate some cherished object or ideal.

The plan should be devised to meet the changing conditions of the times, conceding to each succeeding generation the largest measure of ability to administer its own affairs, and should afford the opportunity for the maintenance of some broad, scientific project in which the donor is interested, while, at the same time, granting great flexibility in the meeting of unforeseen future contingencies. It should avoid specifically those methods of organization which history has shown to be undesirable, particularly as to methods of perpetuating the governing board, the designation of objects to be served, and the safeguarding of the capital. It should utilize legal and economic principles which in recent investigations have been pronounced sound.

The approval and promulgation of some plan by recognized scientific bodies should give a new significance and opportunity to the ownership of wealth and should furnish an incentive for generosity in the disposal of a fortune,

[1] The present note is a skeletal outline of a preliminary report prepared by the writer as chairman of the Committee on the Stabilizing of Scientific Funds. The committee is continued for further work on this problem and welcomes discussion and criticism of the plan from those who are interested in the allocation of funds in trust from wills, bequests, or grants for the encouragement of scientific investigation and service.

because it perpetuates it under a proper guarantee and makes it a permanent instrument in the service of science for the good of mankind.

To meet these needs, a type of organization to be known as the Elector Plan is proposed.

I. THE PLAN

1. A board of trustees entrusted with the administration of a fund shall be elected at stated periods by a committee of electors.

2. There shall be five electors appointed annually, two to be chosen by the board itself and three by some stable institution or institutions designated in the charter.

3. The board of trustees shall be composed of five members or some multiple of five, such as ten or fifteen. Election shall be for five years, and a member shall not be eligible for re-election until after a lapse of one year. Rotation established, one fifth of the board shall be elected each year. Irregular vacancies shall also be filled at the annual election. The chairman of the board of trustees shall be designated annually by the board itself. Either the original board or the original electors may be named in the charter by the donor.

4. The powers and duties of the board of trustees shall be prescribed in the charter, and must include the following provisions: (1) Full power to carry out the provisions of the charter in regard to the organization and supervision of projects and the expenditure of funds; (2) power to adapt the provisions of the charter as to object of funds, to meet changing conditions and needs in the spirit of the original intent of the donor; (3) power to change custodianship of funds, on good evidence for need of change, to guarantee safety and profitable investment. The charter shall also prescribe how any of the institutions which designate electors may be replaced in case of loss of fitness for the service.

5. The funds shall be placed in the custody of a trust company or companies having a capital and surplus of not less than ten million dollars, empowered to make investments and pay out the income with the consent of the board of trustees.

6. The charter shall provide for an annual auditing and public accounting of the expenditures.

II. ADVANTAGES OF THE PLAN

It provides that the board of trustees shall be elected by persons a majority of whom are approved representatives of the science or sciences named, fully conversant with the situation in the age in which they are acting, free from self-interest in the election, and by virtue of their position charged with responsibility for rendering this type of service.

It harmonizes a progressive flexibility and growth in adaptation to purpose as determined by a progressively evolving science with stability and good faith in permanent serviceableness.

It prevents the unwise restriction of funds by donors, the diversion or dissipation of funds by self-perpetuating boards, the loss of value in funds as a result of changing conditions and interests in the service of science, and uninformed and whimsical procedure in the allocation of funds for research.

It serves the purpose of encouraging donors in generous and confident giving of funds for research, creates an interest in this type of permanent and far-sighted service as a personal monument or memorial, and points to the opportunity and wisdom of consulting representative scientific bodies on technical matters in the allocation of funds for research.

III. STABILIZING ORGANIZATION

The National Research Council, a working organization of the National Academy of Sciences, would seem to commend itself as a suitable body for this type of responsibility in that it is permanent, progressively adaptable, representative of the sciences, composed of persons highly qualified for scientific guardianship, and takes a genuine interest in rendering service of this kind with forethought. The National Research Council should therefore hold itself ready to designate one, two or three of the electors in accordance with the wish of the donor as expressed in the charter.

Other agencies, such as other scientific foundations, national societies, state or federal officials, universities, museums, community trusts, or other organizations representing a particular interest involved, may be found suitable for acting in a coordinate capacity with the National Research Council. Among the qualifica-

tions of an organization adapted for such coordinate responsibility with the National Research Council in designating electors, these are essential: That it shall represent the interest involved, shall be permanent, shall be progressively adaptable to the evolution of its function, shall be so organized as to perform this function with a genuine interest and forethought, and shall command a position of recognized dignity and integrity.

C. E. SEASHORE

DIVISION OF ANTHROPOLOGY
AND PSYCHOLOGY,
NATIONAL RESEARCH COUNCIL

ALFRED GOLDSBOROUGH MAYOR

AMERICAN men of science have lost a highly esteemed colleague and friend in the untimely death, at his laboratory at Tortugas, Florida, on June 24, of Alfred Goldsborough Mayor. For about three years past he has been making a heroic struggle against a tubercular infection, followed during the last winter by a severe attack of influenza, while he was at Tucson, Arizona; but the end came sooner than either he or his intimate associates anticipated.

Mayor was born at Frederick, Maryland, April 16, 1868. His early life was spent at Maplewood, New Jersey, where his family lived while his distinguished father was professor of physics at Stevens Institute of Technology. His easy aptitude for learning in general doubtless led him to pursue a course of study in that institute, and he was awarded the degree of mechanical engineer there in 1889. Later on he turned his attention to zoology and pursued studies at Harvard University leading to the degree of doctor of science in 1897. For some years he was intimately associated with Professor Alexander Agassiz as a trusted assistant in the development of the museum of comparative zoology at Harvard and in the other fertile enterprises of Agassiz. From 1900 to 1904 he was curator of the natural sciences of the museum of the Brooklyn Institute. Since 1904 he has been director of the department of marine biology of the Carnegie Institution of Washington, and the more important results of his investigations, and of the investigations of his numerous associates made at the Tortugas laboratory and during his expeditions elsewhere are to be found in the publications of the institution of the past two decades.

A just estimate of the scientific work of Mayor must be left to more competent hands. It is more fitting in a brief notice to call attention to the characteristics he manifested as a man among men. He possessed and practiced in high degree four cardinal virtues of which the world at large is now in great need, namely, the virtues of integrity, industry, reciprocity and moral courage. Although of a distinctly artistic and poetic temperament, he had unusual capacity to see and to understand realities. Few among our contemporaries have understood so well as he the arithmetical limitations, for example, of the Carnegie Institution of Washington. Few men approach the problems of life with the degree of insight and foresight he brought to bear upon them. It is commonly held that men of science are incompetent in fiscal affairs; but this is only an obscure way of stating the fact that men as a rule are inefficient in business. Mayor was a marked exception to the rule. Whatever he undertook was well considered and well executed, and it was never essential to even suggest the aid of a public auditor to interpret his accounts. His versatility was equal to almost any emergency. He was equally at home in the navigation of a ship, in the construction of a laboratory, in the delineation of the delicate tissues of a jelly-fish, and in his associations with the natives of the South Sea Islands. He accepted the situation, whatever it was, and without complaint sought only to improve its conditions. Never aggressive but always persuasive, he was one of the most unselfish of men. In the conduct of his laboratory and of his expeditions, his personal interests were the last to be considered. He afforded a continuous example of the joy in life that comes from getting something worth while well done. He made it easy for, and a source of the highest pleasure to, his associates who worked with him. His normal span was cut short by insidious disease, but he left an impressive and inspiring record in the fields of altruistic endeavor.

R. S. WOODWARD

SCIENTIFIC EVENTS

MAGNESITE IN SOUTHERN NEVADA

A MASSIVE deposit of magnesite of unusual character that has recently been brought to the attention of the United States Geological Survey promises to yield a large and readily available supply of this material. The deposit lies in Clark County, Nevada, in the valley of Muddy River, one of the tributaries of Virgin River, a few miles above the town of St. Thomas. The material has been known for some time as kaolin, and successful experiments for utilizing it as a porcelain clay are reported to have been made, though they have not yet resulted in the exploitation of the deposit. The recognized outcrops have been located as mining claims, and some preliminary exploration and development work has been done. A side track on the St. Thomas branch of the Los Angeles and Salt Lake Railroad, about three miles northeast of the northernmost group of claims, offers a readily available railroad connection, and the station has been named Kaolin from this deposit.

The so-called kaolin is stated by the Geological Survey to be in fact a magnesite and was deposited in a highly magnesian sedimentary bed, a part of a regularly stratified series of sedimentary beds exposed by stream channels that cut across a low ridge at the upper edge of Muddy Valley. The deposit forms a chalky-looking bluff, dazzlingly white in the bright sunlight. The material is porcelain-white, fine grained and massive, is remarkably free from foreign material, and has the structureless appearance and conchoidal fracture that are generally characteristic of magnesite. It is not so hard as the more typical magnesite, and it crumbles more rapidly on exposure to the weather.

The deposit is included between tilted beds of conglomerate and sandstone below and shale above. The lower contact is sharply defined, but the magnesite grades up into the overlying beds. The purer part of the deposit consists of beds aggregating at least 200 feet in thickness. Within the section of purer material there are a few bands of sandy matter, but these are minor in amount and apparently almost negligible, as they could undoubtedly be avoided in mining. The whole section lies in the form of a "hogback"—that is, the softer beds lap up against a uniform slope of the sandstone and conglomerate that has a northeasterly dip of 30° to 50°.

The region in which the deposit lies is in large part covered with alluvial wash, which conceals most of the bedrock formations, so that the section including the magnesite is exposed at only a few places where streams have cut down through the overlying deposits. The regularity of the exposed section and the continuity of the harder beds, which project through the surface wash, justify the assumption that the magnesite is practically continuous between exposures and for considerable distances beyond. Its length at the surface seems to be a mile at least.

THE BRITISH CHEMICAL INDUSTRY

SIR JOSEPH LARMOR, professor of mathematical physics at Cambridge and member of parliament, writes to the London *Times* as follows:

I have no claim to expert technical knowledge on chemical matters, but with others I have been wondering what is involved in the announcement in the House of Commons that the British Dyes Association are entering into negotiation with the German Color Industry Combine.

I well remember the remonstrances of scientific chemists when this national venture was placed under the direction of business men and members of the House of Commons early in the war; but it was reasonable at that time that the energies of the government that was conducting the war should not be distracted on smaller matters.

The welcome letter of Sir William Pope suggests further questions, to which answers must now be available and possibly instructive. Has the American dye industry, also started during the war, been as hopelessly unfortunate as our own? Have the attempts to develop the fixation of atmospheric nitrogen in this country, on methods which supplied the paramount needs of Germany during the war, met with better success? If the industry of fine chemicals is to be worked by British companies supported by the government, under German direction and instruction, what is to become of the armies of young men who, at the universities, have been undergoing long and expensive training in chemistry, in order

to take advantage of the openings that public policy seemed to offer?

We were informed on the highest authority that British effort, in the universities and in technical works, overtook and far out-distanced that long start that German military chemists possessed as regards noxious gases and other agents of chemical warfare. Has that superiority now disappeared, and why? One may even ask, judging from public pronouncements, is the same the case with our war-time superiority in aircraft and the relative scientific problems? Or is it that these things are now back under official control, with copious production of Blue-books?

A dozen years ago my duties threw me in the way of observing some of the great German university chemists who developed into chemical engineers on the grand scale and founded the German industry. While struck by their quiet capacity and apparent friendliness, it did not appear for a moment that they rated themselves higher than their British colleagues who had never had the same opportunities.

AGRICULTURE AND WIRELESS TELEPHONY IN FRANCE

AN editorial article in the London *Times* says:

WHILE England has been considering France has acted and has arranged to bring wireless telephony to the assistance of agriculture. A generous extension of the telephone system to rural districts has long been urged on our own General Post Office. It would help to redress the isolation of the country and it would confer the special benefit of prompt knowledge of approaching meteorological changes. Farmers and gardeners, who are at the mercy of vagaries of the weather, could do much to arrange their work or even to protect their crops were they in possession of weather bulletins such as are posted at harbors for the benefit of fishermen and mariners. But the cost of telephone cables has retarded the progress of extensions, and would, indeed, prohibit even the ultimate completion of a sufficient network. According to a message from our Paris correspondent, printed in our columns last Wednesday, France has overcome the difficulties of cost and distance by a prompt application of wireless telephony. The ministers of air and of agriculture, acting in concert, have arranged that the National Meteorological Office shall "broadcast" a weather bulletin twice daily. Every commune will have a receiving station in the parish school or police station, where the messages will be received and posted. It is proposed, further, that the peasants shall be warned of any sudden storm by ringing the village bell. Such an organization is well suited to rural France, where, for the most part, the owners are the actual cultivators and live in villages from which they sally forth to their fields. It would require modification in this country, where the isolated farm rather than the village is the center which would have to be reached. But messages issued by the Meteorological Office, now under the Air Ministry, could be received at suitably chosen towns, from which they would be redistributed not only to villages, but to farms in possession of the cheap wireless receivers already at the disposal of the general community.

THE MOUNT EVEREST EXPEDITION

AT a recent meeting of the Royal Geographical Society Sir Francis Younghusband, the president, made the following announcement in regard to the Mount Everest Expedition:

As this is the last meeting of the session and consequently the last occasion on which I shall have the honor of addressing you as your president, perhaps you will allow me to summarize the results of the Mount Everest Expedition, so far as we at present know them. The climbers were on June 6 to have made a final effort to reach the summit—or rather the real attempt, for the previous efforts were more in the nature of reconnaissances. But we know that the monsoon broke on June 3 and we fear that this will have definitely frustrated any further effort.

But the expedition has, in spite of terrific weather, already accomplished much. As you know, they have reached 26,800 feet without oxygen and 27,300 feet with its aid. And in accomplishing these great feats they have gained much experience for future use. They have ascertained that the mountain itself at the highest points reached is, in Mallory's words, "not difficult," and Finch and Bruce were able to proceed along the north face without ropes. Mallory was convinced, too, that with favorable weather the porters could have carried a camp to 26,000 feet and so brought the climbers within reach of the summit. And Finch's experience was that by a moderate use of oxygen in camp both sleep and hunger were induced. So that, even if the final climbers did not carry oxygen on them, they might start from their high camp refreshed by its use.

The experience gained this year also shows that skilled mountaineers are able to take those un-

skilled in high mountain craft to the highest altitudes. Geoffrey Bruce had never climbed a snow and ice mountain before. Yet under Finch's skilled leadership he was able to attain a height of 27,300 feet. And the Sherpa porters, though they were practically untrained to snow and ice work, were able, under General Bruce's stimulating influence—and we must gratefully acknowledge that it was he who originated and carried out the idea of forming a corps of these men—to carry loads up to 25,500 feet, some of them making the journey four times and so earning the unstinted praise of the best mountaineers.

So by careful organization and combination of effort, by using experience to guide inexperience, and by the display of indomitable pluck on the part of the highest climbers, the expedition has at a bound brought the record up from 24,600 feet to 27,300 feet, and thus left only 1,700 feet to be climbed before the crowning summit is reached.

The standard of human achievement has thereby been sensibly raised. And many another climber, many another traveler, and many another struggler upward in every walk of life and in every country will be braced and heartened in remembering what Finch and Mallory, Somervell, Norton and Bruce have this year accomplished on Mount Everest. And this, to my mind, is incomparably the most valuable result of the expedition—and a result which makes their efforts in the highest degree worth while.

In conclusion may I quote from an article on mountaineering I have just read? "Mountaineering proper is not necessarily rashness, but is entirely a question of prudence and of courage, of strength and steadiness, and of a feeling for nature and her most hidden beauties, which are often awe-inspiring, but for that reason the more sublime and to a contemplative spirit the more suggestive." These words were written thirty-three years ago by an Italian Alpine climber, a certain Father Ratti. That mountaineer has now become Pope Pius XI and his words exactly express the sentiment which has animated all those connected with the Mount Everest Expedition, whether in its initiation or in its execution—and which will continue to animate them till the final goal is reached.

The *Public Ledger,* in a cable dispatch, announces that the expedition to climb Mount Everest has been abandoned as a result of an avalanche in which seven porters were killed. Three members of the expedition, C. L. Mallory, T. H. Somervell and C. A. Crawford, had narrow escapes. The dispatch said the final attempt to scale Mount Everest had been made on June 7.

ENGINEERS AND AN AMERICAN UNIVERSITY IN EUROPE

ESTABLISHMENT in Central Europe of a great American university and library is urged by Dr. B. Stepanek, minister to the United States from Czechoslovakia, who, to advance international peace, calls upon the engineers of this and other countries for united participation in world affairs. Dr. Stepanek makes an appeal for the formation of a world federation of engineers, and for an international engineering conference to deal constructively with the problems of civilization.

Dr. Stepanek's views, made public by the American Society of Mechanical Engineers, which, through its official journal, stresses the need of engineering solidarity among the leading nations, are regarded by engineers as a significant diplomatic utterance supporting the efforts now being made in America, Great Britain, France and Italy to bring about closer relations among engineers.

Award of the John Fritz medal to Senator Guglielmo Marconi has aroused fresh interest in the idea of a world union of engineers. Marconi's expressed hope of promoting peace through science coincides, it was said, with action to devise a working plan of international cooperation between the engineers of America and Italy.

John W. Lieb, vice-president of the New York Edison Company, has reported, after a trip to Italy, that Italian engineers are ready to form such an alliance. Herbert Hoover, Professor Comfort A. Adams, of Harvard University, Eugene Schneider, of Paris, and Sir Robert A. Hadfield, of London, are others who favored advancement of world peace through the united action of men of science. Actively backing the project also are the presidents of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers and the Federated American Engineering Societies.

Alfred D. Flinn, secretary of the Engineering Foundation, and chairman of the Engineer-

ing Division of the National Research Council, endorses Dr. Stepanek's suggestions "that at an early date there should be an international conference of engineers, rather than of politicians and of statesmen, bound by tradition and self-seeking nationalism—a conference of constructively-minded men who could take fresh views of the world's condition, deal scientifically with fundamental causes, and suggest impartial, far-sighted plans for continuing progress."

In appealing for the establishment of an American university in Central Europe, Minister Stepanek said that it would constitute a center from which could be given out the best products of American culture, a source of correct information about America and American ideas. Through a world alliance of engineers, the minister said, a constructive type of mind could be brought more effectively into the service of the nations.

SCIENTIFIC NOTES AND NEWS

JACOBUS CORNELIUS KAPTEYN, professor of astronomy and theoretical mechanics at the University of Groningen since 1888, has died at the age of seventy-one years.

WILLIAM WISLICENUS, director of the chemical laboratory of the University of Tübingen, died on May 8, at the age of sixty-one years.

DR. EDWIN E. SLOSSON, editor of *Science Service*, received the honorary degree of LL.D. at the recent commencement of the University of Kentucky.

DR. W. S. THAYER, formerly professor of medicine in the Johns Hopkins Medical School, has been elected an overseer of Harvard University.

DR. OTTO KLOTZ has been elected an honorary overseas member of the Norman Lockyer Observatory in England.

M. HENRI LESBEGUE has been elected a member of the Paris Academy of Sciences in the section of mathematics to succeed the late M. C. Jourdan. M. Lesbegues has recently been elected professor at the Collège de France.

AT the meeting of the Royal Society of Edinburgh on June 19, the Keith Prize (1919-1921) was presented to Professor R. A. Sampson for his astronomical researches, and the Neill Prize (1919-1921) to Sir Edward Sharpey Schafer, for his contributions to our knowledge of physiology.

AT a special meeting of the directing board of the National University of Mexico, it was voted to grant an honorary diploma to Dr. S. Ramòn y Cajal. The Mexican Academy of Medicine has appointed him an honorary member.

THE second year's work of the American School in France for Prehistoric Studies began the first week in July at La Quina, Charente, under the directorship of Dr. Charles Peabody. The retiring director, Professor George Grant MacCurdy, will visit Switzerland, Austria, Czechoslovakia, Germany, Belgium and England before returning to Yale University in September.

DR. JOHN L. STENQUIST, who has been assistant to the director of reference and research in the Department of Education of New York City, has been appointed director of the new Bureau of Educational Measurements, Statistics and Research for the city of Baltimore, where he will assume his duties about September 1.

DR. EDWARD A. SPITZKA has been appointed district medical officer, Second District, U. S. Veterans' Bureau. The Second District embraces the state of New York, New Jersey and Connecticut.

HUGH M. HENTON, formerly instructor in metallurgy at Case School of Applied Science, has opened an office as consulting engineer in Cleveland.

PROFESSOR HERBERT H. WHETZEL, who has been head of the department of plant pathology since its organization in the State College of Agriculture at Cornell University, has been relieved from the leadership at his own urgent solicitation in order that he may devote his time exclusively to teaching and research.

PROFESSOR JOEL STEBBINS, of the University of Illinois, who, as was reported early in the spring, has been appointed professor of astronomy and director of the Washburn Observatory

at the University of Wisconsin, succeeding Professor G. C. Comstock, retired, took up his new work July 1. Professor Comstock has been director of the observatory since 1889 and has reached the age of retirement. He has been on the faculty since 1887, and was dean of the Graduate School from 1906 to 1920.

PROFESSOR TRACY E. HAZEN, of Barnard College, Columbia University, sailed from New York on June 21 for Buenaventura, Columbia. Early in July he expects to join the expedition of Dr. Francis W. Pennell and Mr. Ellsworth Killip for botanical exploration of the Cordillera Central of the Andes, returning to New York in September.

PROFESSOR J. A. DETLEFSEN, of the University of Illinois, will take a year's leave of absence during which he will devote himself to the study of the inheritance of disturbances of orientation.

PROFESSOR JUNE E. DOWNEY, head of the department of psychology of the University of Wyoming, has been granted leave of absence for the next academic year and will spend the year in study and travel, part of the time abroad. Miss Louisa C. Wagoner will serve as chairman of the department during Professor Downey's absence and will be assisted by Donald A. Laird of the University of Iowa.

DURING the week of July 24 to 28, Professor H. S. Jennings, of the Johns Hopkins University, will give before the summer session of the Colorado State Normal School at Gunnison, Colorado, a series of five lectures on "Adventures in research on development and evolution."

THE following popular lectures in physics are being given this summer at the University of Illinois:

June 22, Production of sound by the application of heat: Professor C. T. Knipp.

June 29, Relativity: Discussion of phenomena: Associate Professor J. Kunz.

July 6, Recording of sound on photographic films and its application to talking motion pictures: Professor J. Tykociner.

July 13, Wireless telegraph: H. A. Brown.

July 20, Fatigue of metals: Professor H. F. Moore.

July 27, Theories of magnetism: Assistant Professor E. H. Williams.

August 3, The tones from bells: Professor F. R. Watson.

THE second lecture of the series on physics in industry, arranged by the London Institute of Physics, was given on July 4 in the hall of the Institution of Electrical Engineers, by Sir J. Alfred Ewing, whose subject was "The physicist in engineering practice, with special reference to applications of thermodynamics."

ON June 7 a lecture was given by Professor A. F. Holleman, of Amsterdam, at the Imperial College of Science and Technology, under the auspices of the University of London, entitled "Recent researches on substitution in the benzene nucleus."

THE fifth international Neo-Malthusian and Birth Control Conference was held in London on July 11-14, under the presidency of Dr. C. V. Drysdale. Many delegates from abroad were present and the discussions were arranged to take place in several sections. A visit to Dorking was arranged to the birthplace of the Reverend T. R. Malthus.

WE learn from *Nature* that the formal opening of the newly established Metallografiska Institutet of Stockholm has recently taken place. The new institute is under the direction of Dr. Carl Benedicks, whose work on the physical chemistry of metals is well known. An inaugural address was delivered by Professor Arrhenius, who referred to the international character of scientific research, as shown by the presence of foreign representatives at the ceremony, and by the review of the history of metallography contained in the address of Dr. Benedicks.

THE Italian Royal Committee for Scientific Marine Investigations has assumed charge of the Zoological Station at Rovigno, Istria, which was formerly under German administration, and the station is now in active work, under Professor Raffaele Issel as director.

THE Honorary Advisory Council for Scientific and Industrial Research of Canada has made a grant to the department of chemistry of Macdonald College for an investigation of soil acidity. The various methods proposed for the measurement of soil acidity will be

compared, surveys in Quebec will be carried on, and the relation of acidity to crop growth will be studied with a view to deciding whether full or partial correction of acidity should be attempted in soils devoted to specific crops or crop rotations.

THE Public Health Institute of Chicago has undertaken to finance the cooperative research between the University of Wisconsin Medical School and the Chemical Department of Northwestern University, which in the past has been supported by appropriations from the United States Interdepartmental Social Hygiene Board. This research which has been devoted to attempts to improve the treatment of syphilis of the central nervous system has been directed by Dr. W. Lee Lewis and Dr. Frank C. Whitmore, of Northwestern University, and Dr. A. S. Loevenhart and Dr. W. F. Lorenz, of the University of Wisconsin. The Public Health Institute has appropriated $21,600 to both universities for the coming year.

A PARTY from the department of zoology of the Louisiana State University at Baton Rouge spent several days during the latter part of June in an exploring and collecting trip in the waters of the gulf east and south of the Mississippi River delta. Through the courtesy of the Honorable M. L. Alexander, state commissioner of conservation, the party had the use of the yacht of the commission, the *Alexandria,* and her crew. The course followed was from New Orleans through Lakes Pontchartrain and Borgne and Mississippi Sound to the Chandeleur Islands; and a number of the islands *en route,* including several of the federal game preserves, were visited and explored. It is hoped that this may be the first of a series of annual trips for the purpose of studying at first hand not only the bird life but the rich coelenterate, arthropod, molluscan and fish fauna of this fertile region. The members of the party were Mr. Robert Glenk, curator of the Louisiana State Museum at New Orleans, who initiated the trip; Mr. Percy Viosca, Jr., the biologist of the Fisheries Division of the Conservation Commission; Dr. E. H. Behre, Miss A. M. Fuller, W. H. Browning, J. R. Fowler and Miss Jessie Chambers, all of the department of zoology of the State University.

THE Paris correspondent of the *Journal of Industrial and Engineering Chemistry* writes that the French Senate is now considering a first draft of a law organizing an "Office national des recherches scientifiques, industrielles et agricoles." This organization is modeled on the National Research Council of the United States. This plan is said to have been fought from the first by the chamber, which sees in it a duplication of the laboratories of the teaching establishments of the state. It has been decided that the part of the new office would be one of coordination of the different laboratories, not only of the state but also of private industry. There have been established in France some laboratories analogous to the Mellon Institute, and these organizations would cooperate in the work of this office.

ON the occasion of the annual inspection by the General Board of the British National Physical Laboratory on June 29, as we learn from the London *Times,* some eight hundred guests were invited to Teddington, where they had the opportunity of seeing some of the work that is being done. All the various departments were open to view, and the attention of the visitors was drawn to many exhibits with features of special interest. In the aerodynamics department one of the wind channels was engaged in measuring the distribution of pressure over the wings of a model aeroplane, and in another the discontinuous flow of air was rendered visible by a smoke cloud. In the new extension that has been added to the engineering department machines were at work for testing the efficiency of spur gears and of the transmission gears and driving chains of motor-cars. In another new building devoted to the testing of concrete a steel colmun cased in concrete, which had failed in the testing machine under a load of fifty-five tons, was to be seen side by side with an exactly similar column not so cased, which had not been able to sustain more than four tons. Close to this building is a new underground range in which a small projectile is made by an arrangement

of electrical contacts to photograph itself at regular intervals during its flight to the target.

THE British commissioners of 1851 announce the following appointments to senior studentships for 1922:

J. Sybrandt Buck, B.Sc. (Liverpool), research student in chemistry, of the University of Liverpool.

Geoffrey T. R. Hill, B.Sc. (London), research student in aeronautics, of the University of London, University College, late experimental engineer and pilot to Handley Page, Limited.

Albert Edward Ingham, B.A. (Cambridge), research student in mathematics, of the University of Cambridge.

John Edward Jones, M.Sc. (Victoria), lecturer in mathematics, of the University of Manchester.

Cecil Edgar Tilley, B.Sc. (Adelaide and Sydney), research student in geology, of the University of Cambridge.

The senior studentships are intended to give a few selected students of exceptional promise and proved capacity for original work the opportunity of devoting their whole time for a period of not less than two years to the prosecution of scientific research. The studentships are of the value of £400 per annum (with additional allowances. The awards are made by selection from among candidates under thirty years of age who are recommended to the commissioners through the executive authorities of institutions invited to make recommendations. The student is required to devote himself to research in some branch of pure or applied science.

UNIVERSITY AND EDUCATIONAL NOTES

DR. LEON L. SOLOMON, New Orleans, has announced that he will give the University of Louisville the sum of $500 annually, for use in the medical research laboratory of the university. This fund will be known as the Solomon Fund.

THE resignation of J. C. Jones, president of the University of Missouri, has been accepted by the curators of the institution, effective at the close of the college year. Dr. Jones has been a member of the faculty for thirty-eight years and desired to be relieved of the responsibility, as he is now sixty-six years old.

PROFESSOR MILO S. KETCHUM, professor of civil engineering at the University of Pennsylvania, has been appointed dean of the engineering school of the University of Illinois and director of its extension work.

PROFESSOR EARL B. MILLARD, professor of materials of engineering, and Professor Harrison W. Hayward, associate professor of theoretical chemistry, have been appointed assistant directors of the division of industrial cooperation and research of the Massachusetts Institute of Technology.

DR. E. S. CONKLIN, head of the department of psychology of the University of Oregon, has been made acting dean of the Graduate School for the session of 1922-1923, in the absence of Dean George Rebec, who will devote the year to travel and study in Europe.

PROFESSOR EDWARD C. STONE, of the department of chemistry of Trinity College, Hartford, Conn., who has been on leave of absence during the past year, has resigned, and Dr. Charles B. Hurd, of Colby College, Waterville, Me., has been appointed his successor.

MR. H. J. WARING, dean of the faculty of medicine of the University of London, has been elected vice-chancellor of the university for 1922-1923, in succession to Sir Sydney Russell-Wells.

DR. HUGO OBERMAIER has been appointed to the new professorship of prehistoric archeology at the University of Madrid.

DISCUSSION AND CORRESPONDENCE

WHICH IS THE HIGHEST WATER FALL IN THE WORLD?

TO THE EDITOR OF SCIENCE: Mr. Hardy's recent note concerning the reputed height of the Kaieteur Falls in British Guiana raises the moot question as to which really is the highest water fall on earth.

My physiographic studies in the Yosemite region of California, which is *par excellence* the land of water falls have led me to collect data on water falls in different part of the world for purposes of comparison. My information still is far from complete—as necessarily

it must be in view of the scattered nature of the references to water falls in the literature, and in view of our still imperfect knowledge of the mountainous portions of several continents—nevertheless I venture to offer here a few facts and figures that may be of interest in this connection. If more accurate data are available, it is hoped that this note will be instrumental in inducing others to bring them forth.

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However, it may be questioned whether it is fair, in making comparisons with other water falls, to consider the two Yosemite Falls and their connecting cascades as forming together a single unit. Those who would champion the claim to first place of some other noble water fall—and there is no little pride, national, state and local, involved in this matter—might perhaps properly object to such procedure. For the cascades between the upper and lower Yosemite Falls, however beautiful they may be, consist only of small drops, chutes and rapids, and their descent of 815 feet is distributed over a horizontal distance of about 2,000 feet. There are elsewhere many other cascades of a similar kind that are not generally considered worthy of being classed as water falls.

It is to be noted, however, that, even if the point be conceded and the cascades be ruled out, the upper Yosemite Fall, taken by itself, still remains far in the lead as the highest single, unbroken leap of water in the world. This leap measures 1,360 feet in height.

There is, so far as I can ascertain, only one water fall that exceeds the upper Yosemite in height—the Sutherland Fall, in New Zealand. It measures 1,904 feet in height but it is broken about midway by projecting ledges and makes no clear leap of more than 900 feet. The falls of Gavarnie, in the Pyrenees, are, according to some authorities, 1,385 feet high, but they consist of braided streamlets that slide down the seams of an irregularly sculptured cliff and do not fall clear through any notable height.

It seems to me that it would be a matter of no little satisfaction to American geographers —and, indeed, to all American citizens who take pride in the great natural features of their country—if the question of the highest water fall could be definitely settled, and I, therefore, wish to express the hope that others who may have reliable data on this subject will consent to make them known. Personally, I should feel greatly indebted for any information they may be willing to supply.

F. E. MATTHES

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.

A CABINET FOR COLORED PAPERS

FACILITIES for storing the stock of large sheets of colored papers in the psychological laboratory usually fall considerably short of the technical requirements. This is true of all papers that have been surfaced on one side for use in chromatic or achromatic comparisons and more specifically for working out color equations. Such papers should be readily accessible for selection, should therefore be arranged in relatively short series, and should be properly classified and indexed. To these ends it is customary to store the papers in a vertical cabinet built up of some two dozen shallow drawers of suitable dimensions.

On account of the unequal treatment of the two surfaces these papers have a tendency to curl upward. In almost any arrangement of drawers this will lead to tearing, rolling up and final destruction of some of the material in the cabinet. It is a particularly common occurrence in cabinets built to accommodate papers with the short side toward the front and constructed without partitions between the draw-

ers. What psychologist has not experienced some form of emotion when he has envisaged the pile of trash and supertrash accumulated behind the drawers at the periodical laboratory housecleaning festivity! The affective experience of the conscientious director of the laboratory is further embellished by the knowledge that this trash is expensive to replace and wasteful of energy and time spent in reorganizing the contents of the cabinet.

In an earlier attempt to prevent mutilation of papers in this wise a cardboard of medium weight was placed in each drawer on top of the papers. Instructions printed in bold characters advised students and others to replace it before closing the drawer. But since failure to heed the advice did not entail consequences similar to the infraction of a natural law, treatment of the situation by suggestion was unsuccessful. The next step was to tack a piece of cardboard over the back of the drawer and reaching forward about eight or ten inches. While this device proved to be a great help, it did not prevent catching and rolling back at the front of the drawer when it was pulled out.

The best solution of the difficulty seems to lie in a very simple arrangement which if embodied in the original construction of a cabinet ought to be less expensive than a case of drawers, but it can also be installed where drawers are already in use. In the simpler plan the drawers are slides that fit into grooves at the side of the cabinet and are made with strips 1½ inches high at the front and a trifle lower at the back, but affording ample room for the standard-sized sheets. On each slide a heavy cardboard cover is hinged at the back with heavy binder's cloth over the top of the strip and is cut large enough to fall just within the front strip or face of the slide. A leather "pull" or flap by means of which the cover can be readily lifted is fastened to it near the front. The apparent inconvenience of having to pull the drawer almost entirely out before the cover can be sufficiently lifted to extract the papers is more of an advantage than a hindrance in view of the well-known fact that most of the untidiness of cabinets is due to the careless extraction and introduction of papers with drawers insufficiently opened. Papers that lie beneath are thereby frequently pulled or pushed back and crumpled up. If the cabinet were constructed so that the grooves at the sides extended six inches or more, or in other words if the sides of the cabinet were built six or more inches wider than the depth of the slides, the slides could be held in place while the covers were lifted and the papers handled, provided that the remaining slides were always systematically returned to their full extent.

A neat and carefully arranged "color cabinet" is always an asset to the well-appointed laboratory and there seems to be no reason why we should not begin at this point to inculcate the ideals of order and system in the minds of our young scientists and at the same time to increase the efficiency of the laboratory according to those standards for which the newer generation is so valiantly fighting!

CHRISTIAN A. RUCKMICK
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SOME time ago there came under my observation two specimens of early human twins, both of which showed a direct developmental relation to single yolk sacs. For record I published a brief note[1] announcing the discovery of this important condition and emphasizing the single-ovum origin which it implies; in addition were appended several deductions or speculations of secondary importance. In a recent issue[2] of this journal Professor F. T. Lewis has raised certain objections which demand consideration that the intent of my former condensed account be not misunderstood.

The second specimen described in that publication had a single yolk sac and yolk stalk connected to one embryo of the twin pair; the other embryo lacked both stalk and sac. Professor Lewis believes this indicates the early obliteration of one of the originally paired stalks. My interpretation was that an early unequal division of the embryonic mass had left

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one member essentially without a sac, as such. This conclusion was based on the following facts:

1. There is no external evidence of a second yolk sac or stalk although the most careful search was made for them.

2. The umbilical cord lacks a yolk-stalk component, as proved microscopically by serial sections.

3. The single yolk sac shows no indication of a second stump, nor are its vessels suggestively arranged as if at any previous time in relation to a second stalk.

4. Although the yolk stalk normally becomes separated from the *gut* in embryos slightly younger, its connection with the *yolk sac* is retained until later. (On this point Professor Lewis's criticism unintentionally carries the erroneous implication that it is even remarkable that the other stalk had retained its connection with the sac until this period—and hence the early disappearance of one is entirely obvious!).

5. The yolk stalk, with its vessels and investing tissue, usually is recognizable until a considerably later period than the six weeks' embryo in question; Minot records that it persists beyond the fourth month but seems to have disappeared by the sixth; Lönnberg states that portions of its vessels may be found rarely at birth; and in any case they are easily demonstrable in embryos five or more times the size of my specimen.

Evaluating these several points I was led to favor an early primary separation, rather than a late secondary one with the coincidence of precocious disjunction of a stalk and its simultaneously precocious disappearence. After thorough reconsideration I still incline to the same opinion though recognizing fully the possibility of the alternative interpretation which I myself had considered but too summarily dismissed without mention. But whichever interpretation is correct, the real objective of the communication is equally supported, for both refer to a single-ovum origin.

In the further discussion of this specimen several deductions were drawn as to the physiological import of absence of the yolk sac. No implication of morphological development, except mention of the ingrowth of bloodvessels, was meant, and I supposed the context made this clear; if not, several statements must have seemed as revolutionary to others as they did to Professor Lewis. When, therefore, I spoke of the yolk sac as "not essential to the growth of an embryo or the proper differentiation of its parts," I was merely referring to the "growth" (that is, increase in size) of an embryo and its organs, and the coincident "differentiation" (or orderly progress) of its developing parts. The sole aim was to draw attention to the physiological insignificance of the yolk sac as related to growth. This is attested by the remainder of the same sentence: "indeed, the embryo in question is slightly larger than its twin . . . ," and again further on: "In the earliest human embryos known, when it might be of real use, it (the yolk sac) is a simple entodermal sac containing masses of coagulum; growth to a conspicuous size is attained relatively late, long after adequate nutritional relations with the mother have been thoroughly established." Little did I suspect that any one would infer an intended reference to initial morphological development in its strict sense. Of course, the gut and allantois had to form from entoderm somewhere, and the yolk sac, broadly speaking, is the undoubted source, yet it is entirely conceivable that essentially all the yolk sac, as a significant *sac,* might be dispensed with and still the gut would arise from entoderm which for the most part normally forms its roof. With this in mind I wrote that the fission "was presumably such that one received all, or essentially all, the cells destined to form a yolk sac," etc. Again, that I recognized the possibility of a rudimentary or abortive sac is seen in a later sentence: "That tiny vascular anlages of yolk-sac ancestry actually existed . . . is of course conceivable."

In short, my aim was remote from the heresy of denying the gut an entodermal, yolk-sac origin; on the contrary it was to re-emphasize from the functional side precisely what Professor Lewis has designated as a platitude: "But it is universally recognized that the yolk sac does its work in early stages, and . . . usually persists as a functionless rudiment until

birth . . ." When, therefore, the foregoing complete explanation was furnished Professor Lewis he generously replied: "The chief interest in anatomical publications is in the observations they record; and as to the interpretation of the unusual specimens which you described so clearly, we seem to be in entire agreement."

LESLIE B. AREY

NORTHWESTERN UNIVERSITY
MEDICAL SCHOOL

SCIENTIFIC BOOKS

Reptiles of the World. By RAYMOND DITMARS. New York, The Macmillan Company, 1922. pp. xi plus 373; 90 plates, 1 colored.

This book is a reprint of the first edition (1910), the only change being in the arrangement of plates. I believe now, as I did in 1911 (SCIENCE, N. S., XXXIV, pp. 54-55), that it is an excellent popular account of a group that has been neglected by writers on natural history, that it is rather well proportioned, and that it contains much of interest to professional zoologists and herpetologists.

I made a few rather unimportant criticisms in the review of the first edition, viz., a few typographical errors, absence of plate references, too few headings, the amount of space devoted to the habits of captive specimens, and an antiquated nomenclature. Unfortunately, since the text is an exact reprint, these criticisms still apply, and it must now be added that the book is decidedly out-of-date. Twelve years see many additions to our knowledge of even those groups which receive relatively little attention, of which the Reptilia is one: more forms are known, more information upon habits and distribution is available, and the accepted nomenclature is different than in 1910. Much of the new information might well find a place even in a popular book.

It is not because I am interested in systematic herpetology that I protest against the retention in works of this kind of an obsolete nomenclature. Admittedly it is not important in itself to the amateur naturalist whether the racers are called *Bascanion, Zamenis* or *Coluber,* and it may be granted that the use of the latest accepted names would often confuse the amateur naturalist or beginning student who has become familiar with the forms under other names. However, it must also be admitted that the retention of old names in recent popular natural histories and text-books makes it equally difficult for the student to read the modern literature on particular groups. In 1910 there was some excuse for retaining an out-of-date nomenclature, since there was not at that time a recent check-list of the North American reptiles; but the present edition would be much more valuable if the nomenclature were based upon the excellent check-list of Stejneger and Barbour, with the names used in the earlier edition given as synonyms.

In one respect the book is decidedly improved. The total number of pages, including plates, has been reduced from 463 to 419 by printing the plates on both sides of the page. The first edition was too bulky, and the present one would be improved by the use of a thinner text paper.

As I pointed out in 1911, there is a distinct need for a general book upon the natural history of reptiles. This one goes a long way towards meeting this need; but it is sincerely to be hoped that before another printing the old plates will be discarded and the subject matter brought up to date.

ALEXANDER G. RUTHVEN

SPECIAL ARTICLES

THE MEASUREMENT OF EXTREMELY SMALL CAPACITIES AND INDUCTANCES

HYSLOP and Carman[1] have recently described an undamped wave method of measuring small changes of capacity such as are obtained by introducing liquids as the dielectrics in the capacity of an oscillating circuit. Thomas[2] has applied this same beat-note oscillating circuit method to the measurement of the capacity of transmission line insulators.

The authors described[3] a method of using the hot-cathode Braun tube as the detector of

[1] *Phys. Rev.*, XV, p. 243, 1920.
[2] *Electrical Journal*, XVIII, p. 349, 1921.
[3] *Phys. Rev.*, XVIII, p. 331.

frequency change, indicating that the method is sufficiently sensitive to afford a means of detecting such small changes of capacity as are caused by introducing a gas as the dielectric instead of vacuum.

The method is particularly applicable to the determination of the dielectric constants of gases as it will be seen from the following that only the difference between the constant and unity is measured.

Since the authors started the above investigation L. M. Hull of the Bureau of Standards has described[4] the use of the hot-cathode Braun tube to determine frequency ratios.

Two oscillating circuits are made to deflect a cathode beam in two directions at right angles to each other. The combined deflections produce one of the well-known Lissajous' figures. If the two circuits are of exactly the same frequency, say 500,000 cycles, the resulting figure will in general be an ellipse. A change of capacity sufficient to cause a frequency change of 5 cycles per second will cause the ellipse to revolve 5 times per second. The change of frequency, if small, may thus be counted directly. The frequency of the master circuit must be kept constant during the time of observation. This can be done.

Let C_1 be a portion of the capacity in the one oscillating circuit and let it be so arranged that the dielectric may be either vacuum or a gas of dielectric constant K.

Then

$$F = \frac{1}{2\pi\sqrt{L(C+C_1)}}$$

where F is the frequency and C is the capacity of the remainder of the circuit, distributed capacity included. If the introduction of a gas in the condenser C_1 causes a change f in the frequency due to additional capacity ΔC, we shall have

$$F - f = \frac{1}{2\pi\sqrt{L(C+C_1+\Delta C)}}$$

Eliminating L and solving for ΔC

$$\Delta C = \frac{f(2F-f)(C+C_1)}{(F-f)^2}$$

Neglecting f as small compared with F

$$\Delta C = \frac{2f(C+C_1)}{F}$$

Since

$$\Delta C = C_1(K-1)$$

$$K - 1 = \frac{2f(C+C_1)}{C_1F}$$

It is readily seen that the largest error is in the determination of the initial capacities. The preceding equation also indicates that only the excess of the dielectric constant over unity is measured. Should it be found possible to surround the entire capacity with the gas the above equation reduces to

$$K - 1 = \frac{2f}{F}$$

and the method would then be one of quite remarkable accuracy.

If the capacity be kept constant and the inductance varied, the first two equations may be written

$$F = \frac{1}{2\pi\sqrt{LC}}$$

$$F - f = \frac{}{2\pi\sqrt{(L+\Delta L)C}}$$

where C is the entire capacity of the circuit.

Eliminating C we have

$$\Delta L = \frac{2fL}{F}$$

If the master circuit can be kept constant for 60 seconds, and such has already been accomplished, a change of inductance of the order of 1 part in 10^8 can be detected.

The ability to detect so small a change in an inductance makes it now possible to use the inductance as the basis of an ether-drift experiment similar to that of Trouton and Noble.[5] Even though the experiment be doomed to null effect it is nevertheless necessary that it be carried out.

The above method may also be applied to the determination of the magnetic permeabilities of gases.

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L. T. JONES

DEPARTMENT OF PHYSICS,
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[4] *Proc. Inst. Radio Engr.*, 9, p. 130.

[5] *Proc. Roy. Soc.*, 72 (1903), p. 132.

THE AMERICAN CHEMICAL SOCIETY

(*Continued*)

SECTION OF CELLULOSE CHEMISTRY

Harold Hibbert, *chairman*

G. J. Esselen, Jr., *secretary*

Report of the Standard Cellulose Committee.

Report of the Analytical Methods Committee.

Report of the Viscosity Measurement Committee.

The effect of concentrated hydrochloric acid on different celluloses: E. C. SHERRARD and A. W. FROEHLKE. A preliminary report on an investigation to differentiate celluloses from various species of woods by observing the action of concentrated hydrochloric acid by means of the polariscope. Characteristic curves are given showing changes in specific rotation. Cotton and spruce cellulose give similar curves, although it has been shown that mannose is present in spruce cellulose and absent in cotton. For such a comparison a standard cellulose is required.

The effect of salts upon the acid hydrolysis of wood: E. C. SHERRARD and W. H. GAUGER. In a search for a material to act as a catalyst in the hydrolysis of wood a number of salts and acids have been tried. The effect of these added materials upon sugar and alcohol yields, as well as the effect produced by varying some of the conditions under which the hydrolysis was carried out, are given in the report.

Sugar formation in a sulfite digester: E. C. SHERRARD and C. F. SUHM. This paper contains charts showing the rate of formation of sugar during the conversion of white spruce into sulfite pulp by the Mitscherlich and Ritter-Kellner processes. Time and steam pressure appear to exert the greatest influence on sugar formation.

Ethyl alcohol from western larch: E. C. SHERRARD. This report describes the preparation of ethyl alcohol from the difficultly fermentable galactose obtained from western larch. Yields of sugar and alcohol are given for the hydrolysis of the water-soluble portion, the residue remaining after water extraction and the original larch wood. It is pointed out that western larch is the best source of ethyl alcohol of any wood yet studied.

Some of the products obtained in the hydrolysis of white spruce wood with dilute sulphuric acid under steam pressure: E. C. SHERRARD and G. W. BLANCO. A study of products formed in the hydrolysis of wood and wood cellulose has furnished valuable information concerning this reaction and the composition of these two substances. Approximately 20 per cent. of the wood cellulose is hydrolyzed with the formation of mannose, glucose, galactose, xylose and arabinose. Mannose and glucose represent nearly two thirds of these sugars. Spruce cellulose prepared by the Cross and Bevan method yields mannose, glucose and pentoses on hydrolysis with dilute hydrochloric acid. This indicates a marked difference in the chemical constitution of wood cellulose and of cotton cellulose. The latter does not yield mannose or pentose sugars on hydrolysis.

The distribution of methoxyl in the products of wood distillation: L. F. HAWLEY and S. S. AIYAR. At the last meeting of the society it was reported that the methoxyl had been determined in the charcoal, settled tar, dissolved tar, pyroligneous acid and gas, from the distillation of maple wood both treated and untreated with sodium carbonate. This work has been continued to include oak and one softwood and also one other catalyzer, phosphoric acid. In the case of oak and the softwood the increase in methyl alcohol due to sodium carbonate is not balanced by the decrease of methoxyl in the charcoal and the dissolved tar alone (as was the case with maple) but also by a decrease in the methane in the gas. The increase in methyl alcohol due to phosphoric acid was accompanied by decreases in the methoxyl of all the other products.

The chemistry of wood. V: G. J. RITTER and L. C. FLECK. This article records the analysis of eight more species of wood in continuation of similar previous work. No very striking variations in composition were noted. In a study of the distribution of the pentosans it was found that both alpha and beta cellulose contained pentosans, the alpha cellulose containing the higher proportion. The distribution of the methoxyl groups was also studied, and it was found that in general the lignin of softwood contained a greater proportion of the total methoxyl of the wood than the lignin from hardwoods.

The chemistry of wood. IV. The analysis of western white pine and eucalyptus: S. A. MAHOOD and D. E. CABLE. This paper represents a continuation of the investigation of the chemistry of wood carried on by the U. S. Forest Products Laboratory. In addition to those constants determined by Schorger methods are given in this paper for the determination of alpha, beta and gamma cellulose and of lignin. The values obtained for western white pine are in the main similar to those obtained for other conifers, while the values for eucalyptus do not vary greatly from the values previously obtained on broad-leafed

trees. Since, according to the values obtained in this series, the woods fall into two groups of fairly uniform composition, depending upon whether they are from broad-leafed trees or from conifers, the suggestions are made that a more detailed study of the splitting products, particularly the cellulose and lignin, of the woods of these two groups be made.

Some observations on the determination of cellulose in woods. II: S. A. MAHOOD. In a previous communication the author showed that the yields of cellulose from woods obtained by Schorger's modification of the Cross and Bevan method of cellulose determination are higher than those obtained by Seiber and Walter's modification. It was suggested that this difference might be due (1) to a difference in concentration of the chlorine in contact with the sample or (2) to a difference in temperature at which the chlorinations are made. The present paper covers an investigation of these two points. It has been found that the yield of cellulose obtained by the Seiber and Walter method of chlorination can be made to accord with that obtained by the Schorger method by diluting the chlorine used with an equal volume of air. There appears to be no difference in the percentage of cellulose obtained by the Seiber and Walter method when chlorination takes place at zero and at room temperature. The Willard crucible has been found to be more suitable than the Gooch crucible with the fiber pad, as proposed by Seiber and Walter, for making chlorinations of cellulosic materials. The results show that the lower yield of cellulose obtained by the Seiber and Walter method of chlorination is due only to too concentrated a stream of chlorine and not to too high a chlorination temperature.

Preparation of a "standard cellulose": W. O. MITSCHERLING.

Synthesis of derivatives relating to polysaccharides: HAROLD HIBBERT and HAROLD S. HILL. Bromacetaldehyde has been condensed with mannitol, glycerin, glycerin brom-hydrin and various glycols. The bromine atom in the resulting cylic derivatives may be replaced by hydroxyl by boiling with dilute alkali. In the case of glycerin a bicylic derivative is apparently formed at the same time. The condensation products are being subjected to a careful examination in view of their relationship to the anhydro-sugars and polysaccharides.

Synthesis and properties of cylic acetal derivatives: HAROLD HIBBERT and JOHN A. TIMM. Partition experiments carried out on the condensation of a mixture of one mol. each of a 1:2 and a 1:3 glycol with one mol. of an aldehyde show that in the various cases investigated a much higher yield is obtained of the six- than of the five-membered ring compound. Also, the stability of the latter towards dilute acids is much less than that of the former. Similar experiments are being carried out using a mixture of one mol. each of two aldehydes with one mol. of a glycol. The nature of the products resulting from the condensation of various aldehydes (1 mol.) with glycerol (1 mol.) is also under investigation as well as the part played by the catalyst in bringing about such condensations.

Constitution of sedoheptose anhydride and its relation to cellulose: HAROLD HIBBERT. The constitution of this anhydro-sugar first prepared by Hudson and LaForge is probably represented by a 5:7 dilactonyl-configuration for the following reasons: It is stable towards mineral acids so that the absence of an ethylene linking may be assumed. The product is a mono-molecular, stable, crystalline derivative showing no tendency towards polymerization, in this respect differing from the intra-molecular condensation product of a $\gamma\Delta$ di-hydroxy aldehydo-derivative, the outstanding feature of which, as found by the writer, is its rapid ease of conversion into a polymorphic form. The evidence for this view could be found in the oxidation of sedoheptose anhydride to the acid, from which, by elimination of carbon dioxide, levoglucosan should be formed. Experiments with this object in view are in progress. The properties of $\gamma\Delta$ dihydroxy-aldehyde derivatives are being examined, the first under review, viz., 2:keto-5:6 dihydroxyhexane, being found to yield a highly polymerized product when submitted to the intra-molecular condensing action of a small amount of a mineral acid.

Symposium. The action of alkali and acid on cellulose, wood and waste cellulosic material with special reference to the production of cheap cattle foods.

Joint symposium with division of organic chemistry on recent work on the constitution of starch and cellulose.

SECTION OF PETROLEUM CHEMISTRY

T. G. Delbridge, *chairman*
W. A. Gruse, *secretary*

Volume changes in petroleum products: A. P. BJERREGAARD. This paper will deal with some peculiarities exhibited by petroleum oils under

changes of atmospheric temperature conditions when the oil is in tank cars. A set of expansion coefficients that fit the observed phenomena will be included.

The surface tension of petroleum: C. K. FRANCIS and H. T. BENNETT. The surface tension of petroleum from different sections of the United States and of the products derived from the various crudes was determined in order to ascertain whether a relation existed between the surface tension and any other physical properties of the oils. The surface tension of petroleum varies almost directly with the specific gravity, but is influenced by the asphaltic content. The presence of high boiling fractions and high viscosity products tends to raise the surface tension of the lighter petroleum products, such as gasoline and naphtha. The small quantity of sulfur compounds, amorphous and crystalline wax, fatty acids and related substances commonly found in petroleum products do not appear to appreciably influence the surface tension. The surface tension at 85° F. of the substances examined varies as follows:

Crude	28.8	31.2
Gasoline	24.4	25.8
Naphtha	26.3	29.2
Kerosene	30.7	31.2
Gas oil	33.1	
Lubricating oil	36.0	37.5
Wax distillate	33.6	36.2

The change in viscosity of oils with the temperature: WINSLOW H. HERSCHEL. It is often necessary to estimate the viscosity of an oil at one temperature from an observation made at another. While it is not convenient to do this by equations, because no two petroleum oils are alike, and the relation between viscosity and temperature is complex, a graphical method has been developed which it is believed is accurate enough for commercial purposes. The method depends upon the observed fact that the graphs of a logarithmic viscosity-temperature diagram will, under certain conditions, meet at a point.

Some notes on the determination of the absolute viscosity of petroleum oils: W. H. FULWEILER and C. W. JORDAN. In connection with the determination of absolute viscosity, of certain samples of petroleum products, it was noted that the viscosities decreased when the sample had been left in the viscosimeter for 24 hours. In other samples, the viscosity increased on standing. Some data is given showing the effect on viscosity of various samples of petroleum, vegetable and animal oils. Some suggestions are made as to the cause of this phenomenon.

Detonation characteristics of blends of aromatic and paraffin hydrocarbons: THOMAS MIDGLEY, JR., and T. A. BOYD. The compressions to which aromatic hydrocarbons can be subjected in internal-combustion engines without detonation are very high as compared to the initial compressions that can be employed when paraffin hydrocarbons are used as fuel. Accurate measurements have been made through a wide range of relative composition of the tendency of blends of these hydrocarbons to detonate in engines. Values are given for the limiting compression ratio at which the various blends will give combustion that is free from detonation. The new instrumentation used for the accurate measurement of the degree of detonation occurring during the combustion of the fuel mixture in the engine is described.

The catalytic oxidation of insulating oils: C. J. RODMAN. Many oils used in electrical apparatus for insulating purposes tend to slowly form "deposits" known to the trade as oil sludge. Experiments have been carried out in both open and closed systems to substantiate the view that numerous substances may act continuously in small quantities to materially assist in the formation of the undesirable sludge. Such substances found somewhere in the transformer or circuit breaker construction are: copper, brass, lead, iron, tin, organic resins, oxidized asphaltic "varnishes" and some loading materials such as magnesia, calcia and a small proportion of certain driers found in the protective paints. Properly protected materials of electrical apparatus construction are discussed as well as the desirability of protecting the oil from oxygen contact.

Corrosion of petroleum refining equipment: R. R. MATTHEWS and P. A. CROSBY. The authors have shown in earlier papers that in refining Mid-Continent petroleum in a so-called pipe still hydrochloric acid was formed, due to hydrolysis of the magnesium chloride in the brine associated with the petroleum. Ammonia has been used in the fractionating system to reduce the corrosion caused by the acid. The cost has beeen small and results gratifying. This paper shows that hydrochloric acid is also produced when Mid-Continent crude is refined in shall stills arranged in series for continuous operation. The action was especially noted in stills where the oil temperatures were 175° C. to 250° C., and where bottom steam was used. The acid corrosion was also noted in a heat exchanger where the outgoing crude oil was not over 110° C. Evidently the acid formation was small there, however, as the ex-

changer was in use one and one half years before a tube was corroded badly enough to give away.

Recent developments in the methods for the extraction of gasoline from natural gas: FRED E. HOSMER and F. M. SEIBERT. The commercial importance of the natural gas gasoline industry is reviewed. The chemistry of natural gas is briefly discussed. Two new methods of gasoline extraction are described. The first is known as the low pressure evaporation method, in which the crude product is utilized to furnish refrigeration for cooling the gas after being subjected to pressure. The second method is known as the crude oil absorption method. This method consists in subjecting the gas to about fifty pounds pressure, at ordinary temperatures, and absorbing the gasoline in crude oil, carrying the saturation to about 25 per cent.

Petroleum education: EDWIN DE BARR and FRED W. PADGETT. A survey of petroleum education from the standpoint of pedagogy and practical application throughout the course of several years. The paper is outlined as follows: I, Relation of the various branches of engineering to the petroleum industry; II, Theoretical discussion of petroleum education; III, Petroleum education at the University of Oklahoma; IV, The future of petroleum education. The writers realize that the subject of petroleum education, especially from the standpoint of chemistry, is in a formative stage and it is hoped that the present paper will stimulate discussion and that outlines of courses in other institutions will be presented.

Sulfur compounds and the oxidation of petroleum oils: C. E. WATERS. In general, mineral lubricating oils which contain large percentages of sulfur compounds are more easily oxidized than those in which there is less sulfur. This is true whether the oils are heated to 250° C., as in the oxidation method for determining the "carbonization values" of oils, or when the oils are exposed to sunlight. The precipitates formed on diluting the oxidized oils with petroleum ether contain higher percentages of sulfur than the original oils. The residues left behind on cracking and partially distilling off oils, as in the Conradson carbon residue test, tend to retain the sulfur in the oil. The bearing of these facts upon the formation of sludge in transformer and turbine oils and of carbon in internal combustion engines is pointed out.

DIVISION OF WATER, SEWAGE AND SANITATION

A. M. Buswell, *chairman*
W. W. Skinner, *secretary*

The effect of temperature on the rate of reaction in water softening by the lime-soda ash method: EDWARD BARTOW, M. E. FLENTJE and W. U. GALLAHER.

Observations on the mechanism of iron removal: A. M. BUSWELL.

Specific gravity of mineral waters by calculation: J. W. SALE.

Bottled mineral waters of unusual composition: W. W. SKINNER, C. H. BADGER and J. W. SALE. The composition of the domestic and foreign bottled mineral waters examined in the water and beverage laboratory of the Bureau of Chemistry during the last fifteen years is discussed with particular reference to the presence of unusual constituents or of ordinary constituents present in unusual amounts. The majority of these waters belong to one or another of the three following types: First, those in which the dissolved mineral constituents consist chiefly of dissolved limestone or of dolomitic limestone; second, of sodium bicarbonate and sodium chloride; third, of either or both sodium sulfate and magnesium sulfate. Usually a determination of the acid radicals, namely, nitrate, chloride, sulfate, carbonate and bicarbonate, and of the basic radicals, iron, aluminum, calcium and magnesium, together with a calculation of the sodium by difference, will furnish sufficient knowledge as to the composition of a water, provided qualitative tests are made for the more unusual constituents. Ordinarily, constituents other than those mentioned and silica are present only in traces. There have been some exceptions to the above, and instead of traces only substantial amounts of certain constituents enumerated below were found. The following maximum amounts of constituents expressed in milligrams per liter are reported: nitrate, 5700.; nitrite, 10.; hydrogen sulfide, 496.; bromide, 1510.; iodide, 30.; fluoride, 0.4; phosphate, 32950.; borate, 2000.; saline ammonia, 69.; lithium, artificial water, 288.; natural water, 32.; strontium, 200.; barium, 18.; manganese, 50.; and arsenic, 15. The composition of the so-called iron and alum waters is discussed briefly.

Two instances in which acute troubles were explained by means of the p_H *determination:* W. F. MONFORT.

Hydrogen ion concentration and coagulation: W. D. HATFIELD. For the majority of water works laboratories Gillespie's method for determination of p_H values, without buffer solutions, is most applicable. The amount of alum required for coagulation of a water is dependent on the buffer value of the water or the methyl orange alkalinity. Turbidity has very little effect. Coagulation begins at a p_H of 7.6-7.8 and the

flock settles readily until a p_H of 6.6 is reached. The Highland Park filtration plant operated most efficiently at a p_H of 7.3 but most economically at 7.5-7.6.

Formulation of equilibria in the coagulating basin: A. M. BUSWELL.

Report of committee on standard methods of analysis: A. M. BUSWELL.

CHARLES L. PARSONS,
Secretary

THE KENTUCKY ACADEMY OF SCIENCE

THE ninth annual meeting of the Kentucky Academy of Science convened in the physics lecture room of the University of Kentucky on May 20, with President G. D. Smith in the chair.

Twenty-three new members were elected. Officers elected are: Lucien Beckner, Winchester, *president;* John A. Gunton, Transylvania College, Lexington, *vice-president;* A. M. Peter, University of Kentucky, Lexington, *secretary,* and W. S. Anderson, University of Kentucky, Lexington, *Treasurer.* A. M. Peter holds over as representative in the council of the American Association for the Advancement of Science.

The following are abstracts of the communications:

The Boleti of Kentucky: G. D. SMITH, Eastern Kentucky State Normal School (President's address). Colored lantern slides and stereoscopic photographs of 37 species of boleti observed in the vicinity of Richmond were presented and explained.

Factors affecting the germination of the sclerotia of Claviceps (Ergot of rye): FRANK T. MCFARLAND, University of Kentucky. Most mycologists are fairly well acquainted with the method of germination of sclerotia of Claviceps, but there still remain several factors which are poorly understood. During the past two years, the writer has been engaged in a study of the sclerotia of ergot from various countries. In the course of these investigations it has been found that sclerotia more than one year old failed to germinate. Sclerotia sown out of doors, on the surface of the soil, without any covering showed good germination of the sclerotia with many well-formed stromata but the stalks usually are short. Some mycologists seem to have the idea that these sclerotia may have the power to retain their germination ability for more than one year. It is quite unlikely that any sclerotia under out-of-door conditions should remain dormant during the first spring after their maturity and germinate the second season. Sclerotia of Claviceps must go through a period of rest. The shortest period of rest so far found is about eight weeks. During this time when the sclerotia are at rest, they must be kept stratified in moist sand. Removal of the cuticle of sclerotia with a scalpel does not prevent the germination, but the stromata are nearly always deformed, and all seem to rise from a stromatic cushion. Treating the sclerotia with a 5 per cent. and a 30 per cent. NaCl salt solution, and then completely removing all traces of the salt and stratifying the sclerotia in the usual manner did not injure their germination power.

The rôle of manganese in plants: J. S. MCHARGUE, Kentucky Agricultural Experiment Station. The purpose of this investigation was to determine if manganese has any definite function to perform in plant economy. The method of attack has been the preparation of plant nutrient compounds and quartz sand, free from manganese, and the growing of plants in different portions of nutrient solutions or sand cultures from which manganese was withheld and in another equal number of portions of these media to which manganese was added. All the plants were grown until those that received manganese showed signs of fructification and a few to maturity. The plants from which manganese was withheld made a normal growth for about six weeks only. Thereafter they became chlorotic and the young leaves and buds died back and the plants made no further growth of any consequence, whereas the plants to which manganese was available grew in a normal way and fructified where the plants were grown to that state of maturity.

The author concludes that manganese is necessary in the plant economy and that, therefore, eleven elements are necessary for the normal growth of autotrophic plants, whereas it has been taught previously that only ten are necessary.

The hydroxy-anthraquinone derivatives in plants: JOHN ABERDEEN GUNTON, Transylvania College. A résumé was given of the various plants containing derivatives of this type as well as a description of the forms in which these occur. The cathartic principles of cascara, senna, rhubarb, aloes and buckthorn were shown to be irritant anthracene derivatives that exist in the plant in the form of glucosides to which the physiological action is presumably due. Plants containing these bodies are found widely distributed throughout the globe and present an interesting

stage in the chemical evolution of plant life. Considerable remains yet to be done on this group from the analytical and synthetical standpoints.

Some seed-borne diseases of agricultural crops: W. D. VALLEAU, University of Kentucky. Further studies on the extent of seed infection of corn with *Fusarium moniliforme* confirm previous reports that it is practically universal. The organism is carried between the various seed-coat layers and may extend in as far as the aleurone layer. In very flinty corn the organism remains dormant a longer period after the seed is planted than in the poorly filled starchy kernels. A preliminary study of 8 lots of barley from 3 states, 12 lots of oats from 4 states, and 38 varieties of wheat from 5 states indicates that small grains are infected to a higher degree with pathogenic organisms than has generally been suspected. Morphological studies of lettuce seeds have demonstrated the presence of an organism in a high percentage of seeds which is believed to be the causal organism of lettuce root rot. The universal presence of root rot on clovers and the results of preliminary tests of seed infection suggest that the causal organism is constantly present in clover seed. Observations on crops affected by seed-borne root disease organisms, grown under different seasonal conditions, suggests that these organisms may play an important part in geographical and seasonal distribution of certain wild and crop plants.

A preliminary report on a study of various clovers as found on three soil experiment fields of Kentucky with special reference to root systems: E. N. FERGUS and W. D. VALLEAU, University of Kentucky. An ecological and pathological study is being made of various clovers, particularly red clover, growing on three soil types of Kentucky, in order to determine the causes of clover failure. Actual counts showed that red and alsike clover stands were practically equal throughout the first year whether on productive or "clover sick" soils. Much diminution of stand occurs on most soils during the second summer, reaching 100 per cent. on the least productive soil. Root rot was present to some extent on all root systems examined. Those developed in least productive soils were badly diseased or dead at the end of the first season. All tap root systems examined were badly diseased or dead at the end of the second season. The persistence of a clover plant after death of the tap root system depends on its ability to produce new roots from the crown.

Extraction of crude oil by means of shafts and tunnels: HENRY MEIER, Centre College. This method of recovery of oil from beds has been successfully carried on in Alsace since 1917. Experience has shown that by means of wells and pumps not more than 20 per cent. as a maximum of the oil contained in a bed can be brought to the surface. The recovery by sinking a shaft and digging tunnels through oil-bearing sand enables the recovery by seepage and by treating the sand with hot water, of two and a half times as much oil as by means of wells. This method of recovery increases the value of a concession. It opens to countries whose oil-bearing regions seem to have reached the end of production, new and encouraging prospects.

Depletion of Kentucky crude oils: W. R. JILLSON, State Geologist, Director of the Kentucky Geological Survey. Although petroleum was first produced on the South Fork of the Cumberland River in 1819, the industry in Kentucky may be said to have gained its feet in 1900, when 62,259 barrels were produced. Production increased steadily until it exceeded 1,200,000 barrels in 1905 and 1906, after which it steadily fell off to 407,081 barrels in 1915. From that time it increased rapidly to 9,226,473 barrels in 1919 and has continued near 9,000,000 barrels. The author thinks that a production of 150,000,000 barrels in the next 60 years is a conservative estimate.

Oil shales of Kentucky: C. S. CROUSE, University of Kentucky. The oil consumption in the United States is outstripping the domestic production, creating an alarming situation. New sources of oil must be found. Oil shale will solve the problem so soon as the extraction of oil from this source is made commercially feasible. A research has been in progress at the University of Kentucky for three years with the development of a commercial retort as its object. The results are more than encouraging. Kentucky has 90,000,000,000 tons of shale immediately available for steam shovel methods of mining. This shale, conservatively figured, represents 40,000,000,000 barrels of crude oil. Kentucky shales show marked superiority over shales in other parts of the United States. Such being true Kentucky is the logical place for the genesis of the oil shale industry in this country.

Model showing structure of Gainesville oil pool, Allen County, Ky.: E. S. PERRY, University of Kentucky. The author exhibited the model showing the stratification and explained its construction.

Table moving by so-called spirits: GLANVILLE TERRELL, University of Kentucky. An example of table-moving produced in daylight by a girl of fifteen and a boy of ten with no possibility of

collusion, was described by the author, as having come under his observation. The author is convinced that the phenomenon was genuine but asserts his disbelief that it was a spiritual manifestation.

A Kentucky chemist of the old school: ALFRED M. PETER, University of Kentucky. J(ohn) Lawrence Smith, M.D. (1818-1883), a citizen of Louisville, Ky., from 1854 to 1883, is most esteemed by the chemist engaged in mineral analysis by reason of the unique and very practical method for the determination of alkalies in silicates of his devising. Indeed, the extensive study of the potassium content of Kentucky soils, by the experiment station, was made practicable by the application of this method. Dr. Smith's publications number some 150 titles, a large proportion of which appeared in the *American Journal of Science*. His work was mainly in mineral chemistry. His investigations on emery led to the development of the emery industry in the United States. He made a life study of meteorites, of which he had a very fine collection, now owned by Harvard University. Dr. Smith occupied a high position in the scientific world and was an active member of many learned societies both foreign and American, including the National Academy of Sciences. The Lawrence Smith medal of the National Academy, a gold medal worth $200, to be awarded for research upon meteorites, was established by Dr. Smith's widow, who used for the endowment the sum of $8,000 received from the sale of his collection of meteorites to Harvard University. The medal has been awarded only twice: to H. A. Newton, in 1888, and to Dr. Geo. P. Merrill, in 1922. Dr. Smith was a man of means, charitable, public spirited, always ready to contribute his scientific knowledge for public good, and was held in high esteem in the community.

Home economics as a science: MARGARET WHITTEMORE, University of Kentucky. Before considering home economics in relation to natural sciences it must be remembered that it has a vital connection also with social sciences and with the fine arts. For this reason, and also because it is distinctly an applied subject, its relation with the natural sciences should be chiefly that of producer and consumer. Home economics, however, should contribute to scientific knowledge by suggesting problems which need attention and by providing the situations for application and experimentation. The earnest attention now being given to home economics reveals several weaknesses. One is the fact that as a course of study it has been organized too much upon a logical in opposition to psychological basis. This seems still true of much of the teaching of the natural sciences, as shown by the requirement of inorganic before organic chemistry. Another cause of weakness is the failure to recognize the desirable limits of home economics and the frequent attempt to teach in the department the principles as well as the application of the arts and sciences involved.

The measurement of the mental changes after the removal of diseased tonsils and adenoids: GLADYS MARIE LOWE, University of Kentucky. A group of thirty-five school children operated upon for diseased tonsils and adenoids was compared with a group of twenty-five which did not undergo the operation. This study is unique in the use of a control group of children with diseased tonsils and adenoids but not operated upon. Three lines of evidence were used, namely, changes revealed by a scale of tests of mental alertness, by the teacher's estimate of certain traits, and by the actual scholarship records. The comparisons are made between data obtained just preceding the operation and those obtained one year after the diagnosis. The Stanford Revision of the Binet-Simon Scale for measuring mental alertness was used. The teacher's rating for each trait was obtained by estimating in which fifth of the class the pupils belonged. The traits estimated were: (1) companionship with fellows, (2) emotional self control, (3) initiative, (4) self expression (speech), (5) interest in school work, (6) attention and (7) scholarship. The results show that: (1) While the average scholarship of the operated group continued to be the same as that of all the classes represented, the average scholarship of the non-operated group fell one scholarship rank below the average of all the classes represented. (2) The operated group showed no more change in the mental age, or in "brightness" (I.Q.) than did the non-operated group. The differences compared with the error were so slight as to be negligible. (3) The teacher's estimates showed no significant change. (4) Pronounced improvement was found in three or four cases.

The importance of scientific investigation in marketing: O. B. JESNESS, University of Kentucky. Attention was called to the growing complexity of marketing methods and a comparison of present methods with the comparatively simple methods that sufficed a century ago was made in order to suggest some of the reasons why the marketing system of to-day necessarily is involved. Mention was made of the prevalence of loose thinking and talking on marketing questions.